NWIS Web Services Geodatabase Snapshot Tool for ArcGIS 10: Colorado Mineral Belt Case Study

United States Geological Survey
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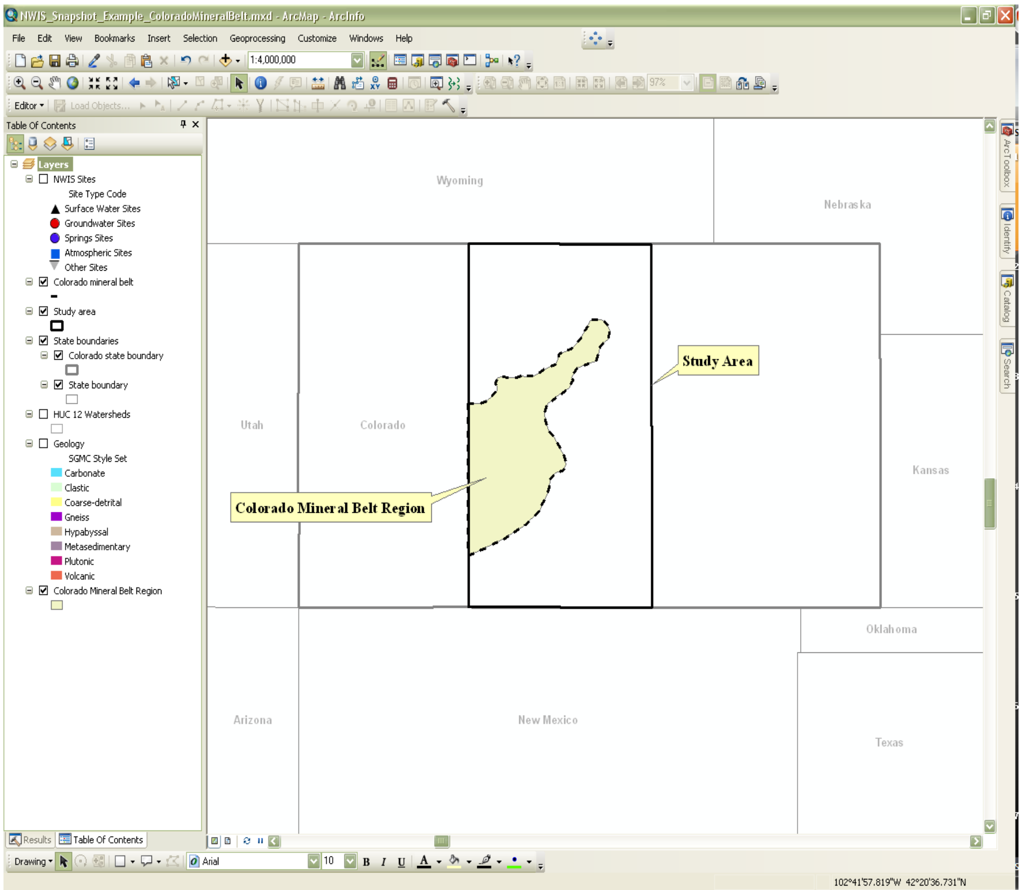
Tutorial: Colorado Mineral Belt Case Study

This tutorial is based on research documented in a report titled "Geochemistry of surface water in alpine catchments in central Colorado, USA: Resolving host-rock effects at different spatial scales" by Richard B. Wanty, Philip L Verplanck, Carma A. San Juan, Stanley E. Church, Travis S. Schmidt, David L. Fey, Ed H DeWitt, and Terry L. Klein.

In their study, Wanty and co-authors carried out a sampling program to evaluate regional environmental geochemistry in the context of catchment lithology. This research was in an area of Colorado known as the Colorado mineral belt—an area of significant historical mining activities, which is reflected in water quality analysis for the area (Figure 1). For this project, the researchers used geographic data such as catchment areas, and lithologic groups derived from regional-scale geologic maps with water quality samples they collected in the field to resolve host-rock effects at different spatial scales.

For this tutorial, we will learn how to use the NWIS Snapshot Tool to load water quality monitoring sites that might be used for a study of this nature. We will also find out how to narrow the number of sites we are interested in to a specific area, namely the sites within the Colorado mineral belt which are monitoring Strahler level 1 and 2 streams. We will also use geologic data to identify the lithologic groups for headwaters of streams in our case study.

Figure 1.	Study area and location of Colorado mineral belt.



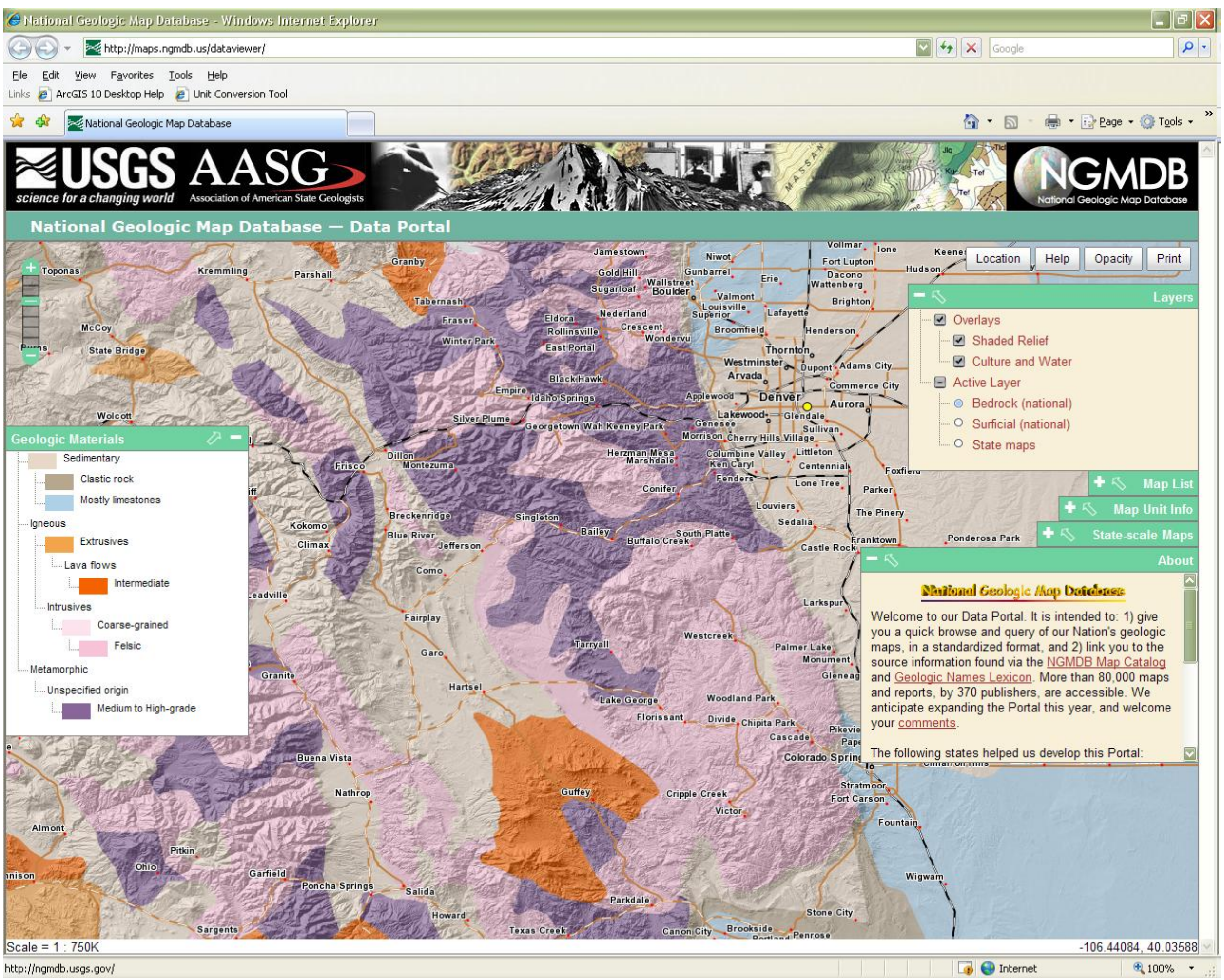
Acquiring Base Layers

This tutorial uses USGS GIS base layers acquired for hydrology and geology. You can acquire these data from the location described in the following sections.

Geology

One of the many Web sites the USGS hosts is a Web site that provides access to the National Geologic Map Database, which is available from: *http://ngmdb.usgs.gov* (Figure 2). This Web site is a resource for maps and related data about geology, hazards, earth resources, geophysics, geochemistry, geochronology, paleontology, and marine geology. Using the Interactive Data Portal tool, you can easily review available data and download what you need.

Figure 2. National Geologic Map Database – Data Portal *http://ngmdb.usgs.gov*

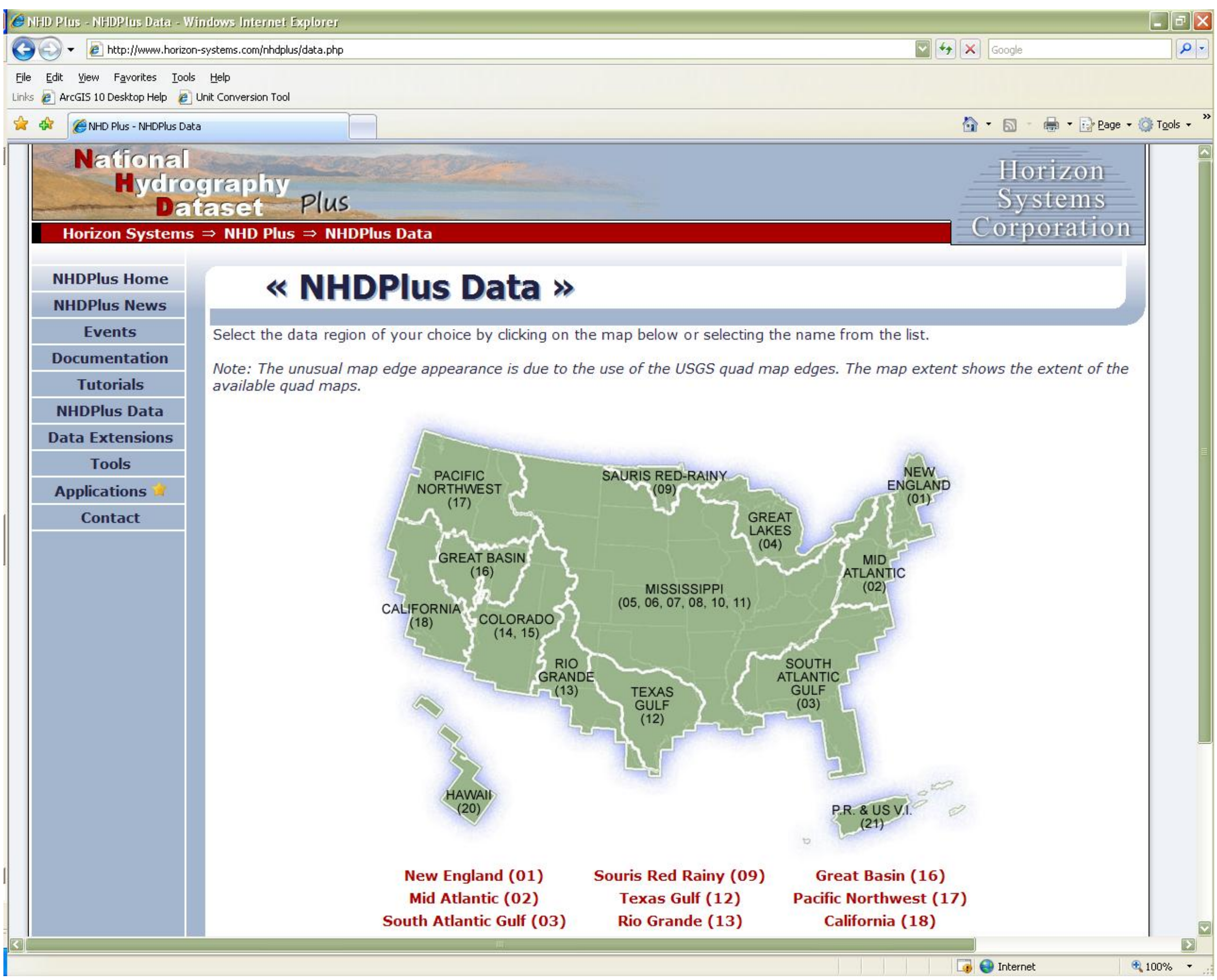


NHDPlus Streams

The USGS also hosts a website through Horizon Systems to allow access to NHDPlus Hydrography data (*http://www.horizon-systems.com/nhdplus/*) (Figure 3). The NHDPlus dataset provides quite a bit of information in one package, including:

- Greatly improved 1:100K National Hydrography Dataset (NHD)
- A set of value added attributes to enhance stream network navigation, analysis and display
- An elevation-based catchment for each flowline in the stream network
- Catchment characteristics
- Headwater node areas
- Cumulative drainage area characteristics
- Flow direction, flow accumulation and elevation grids
- Flowline min/max elevations and slopes
- Flow volume & velocity estimates for each flowline in the stream network

Figure 3. NHDPlus Data Web Site *http://www.horizon-systems.com/nhdplus/*



Setting up base layers

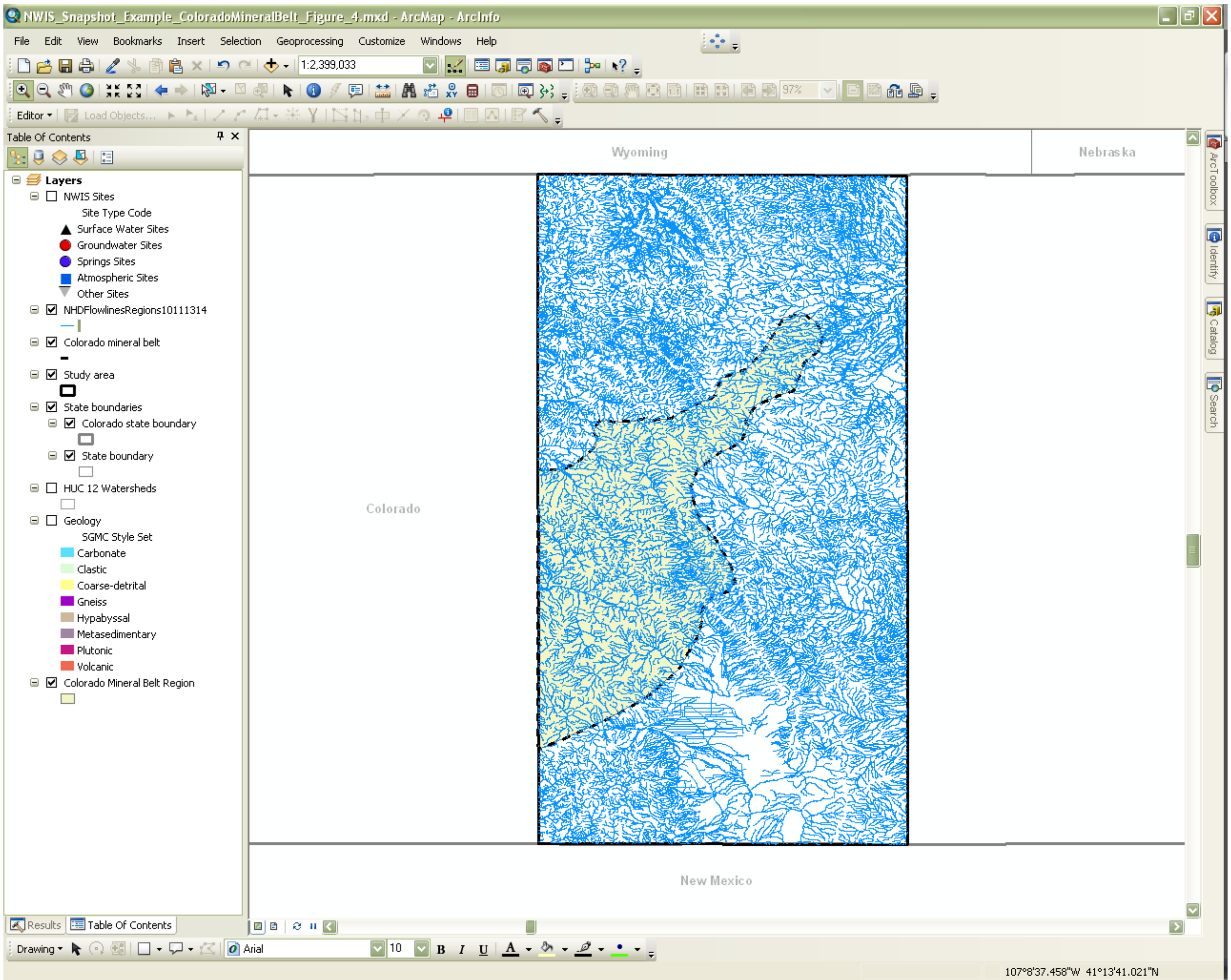
When you download sites for an area using the NWIS Snapshot Tool, you will receive sites for the entire extent of the current “data view” within the ArcGIS session you are using. You may actually want to confine your study to a certain area based on specific criteria. For this case study, we only want to look at sites within the Colorado mineral belt region that are located on Strahler level one and two streams whose headwaters originate in relatively uniform, homogeneous headwater lithologies.

Determining a study area based on specific criteria

A. Our first criteria for our sites is that they must be on Strahler level one and two streams within our study area. So, we must first determine which streams meet our selection criteria.

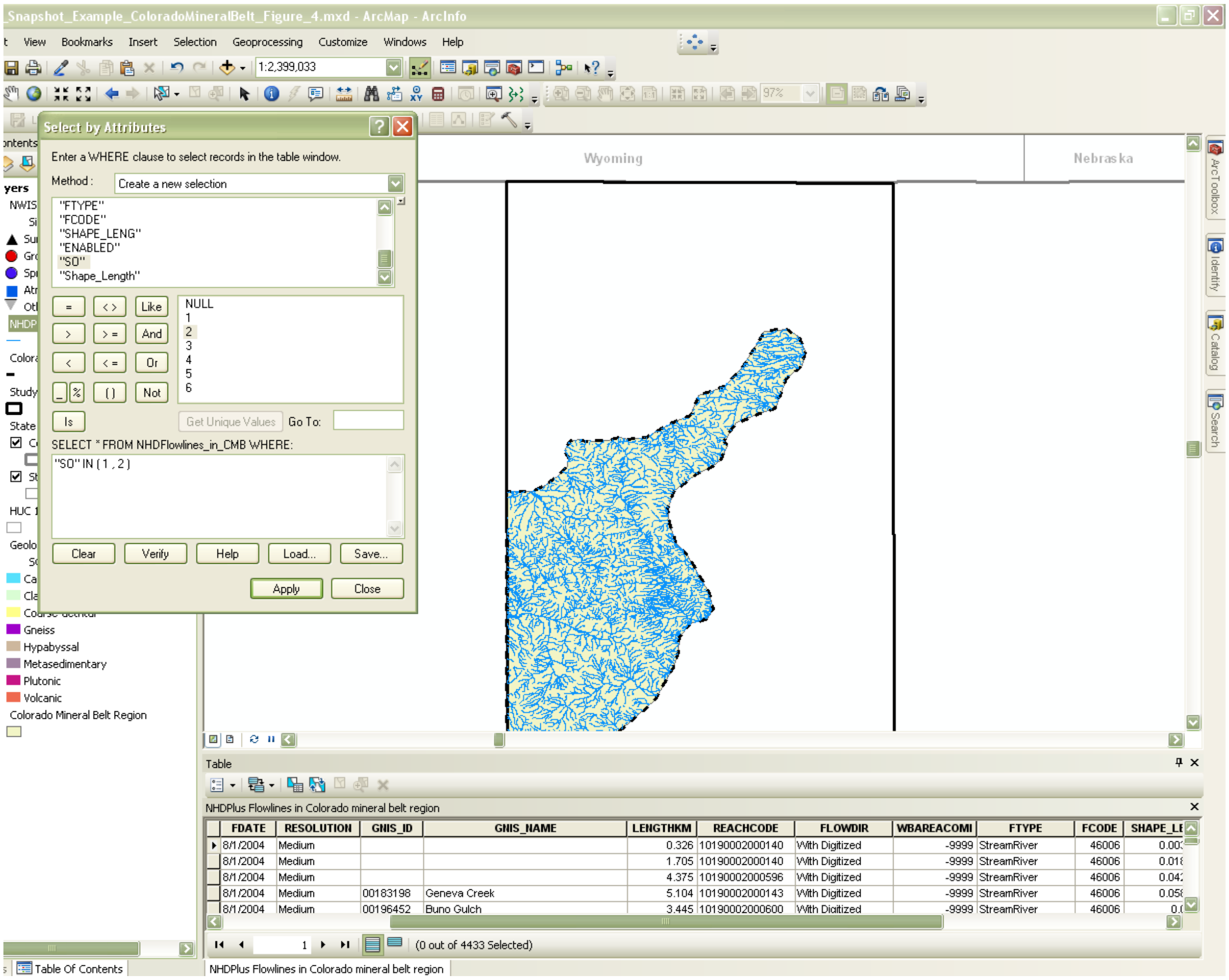
Step 1: Load the NHDPlus stream data into ArcGIS. In this example, the streams are clipped to the study area boundary (Figure 4).

Figure 4. All NHDPlus streams within the Colorado mineral belt study area.



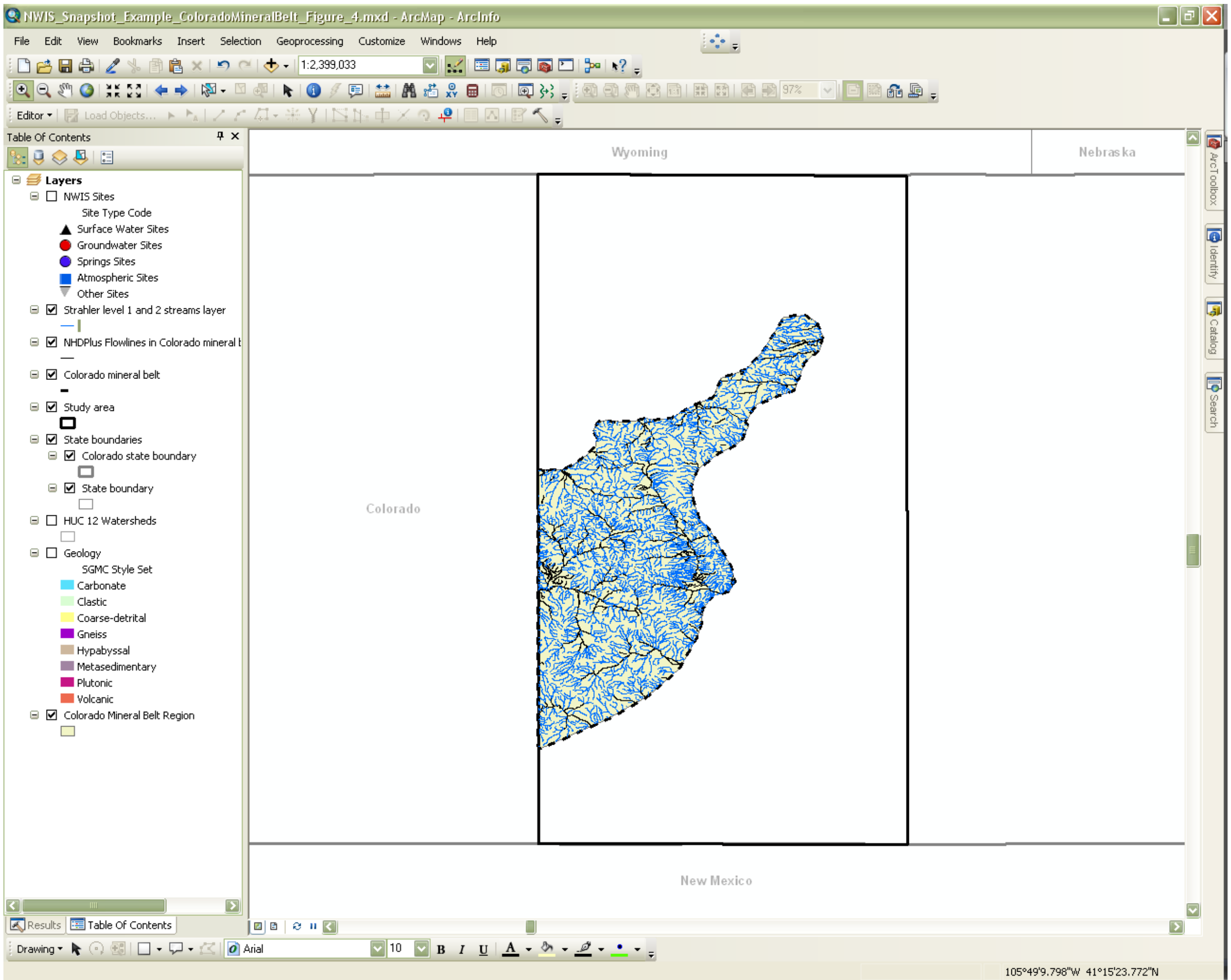
Step 2: Select all Strahler level one and two streams from the flowtable in the NHDPlus database (Figure 5).

Figure 5. Select all Strahler level one and two streams by attributes from the flowtable of NHDPlus.



Step 3: Create a selection layer for the Strahler level one and two streams (Figure 6).

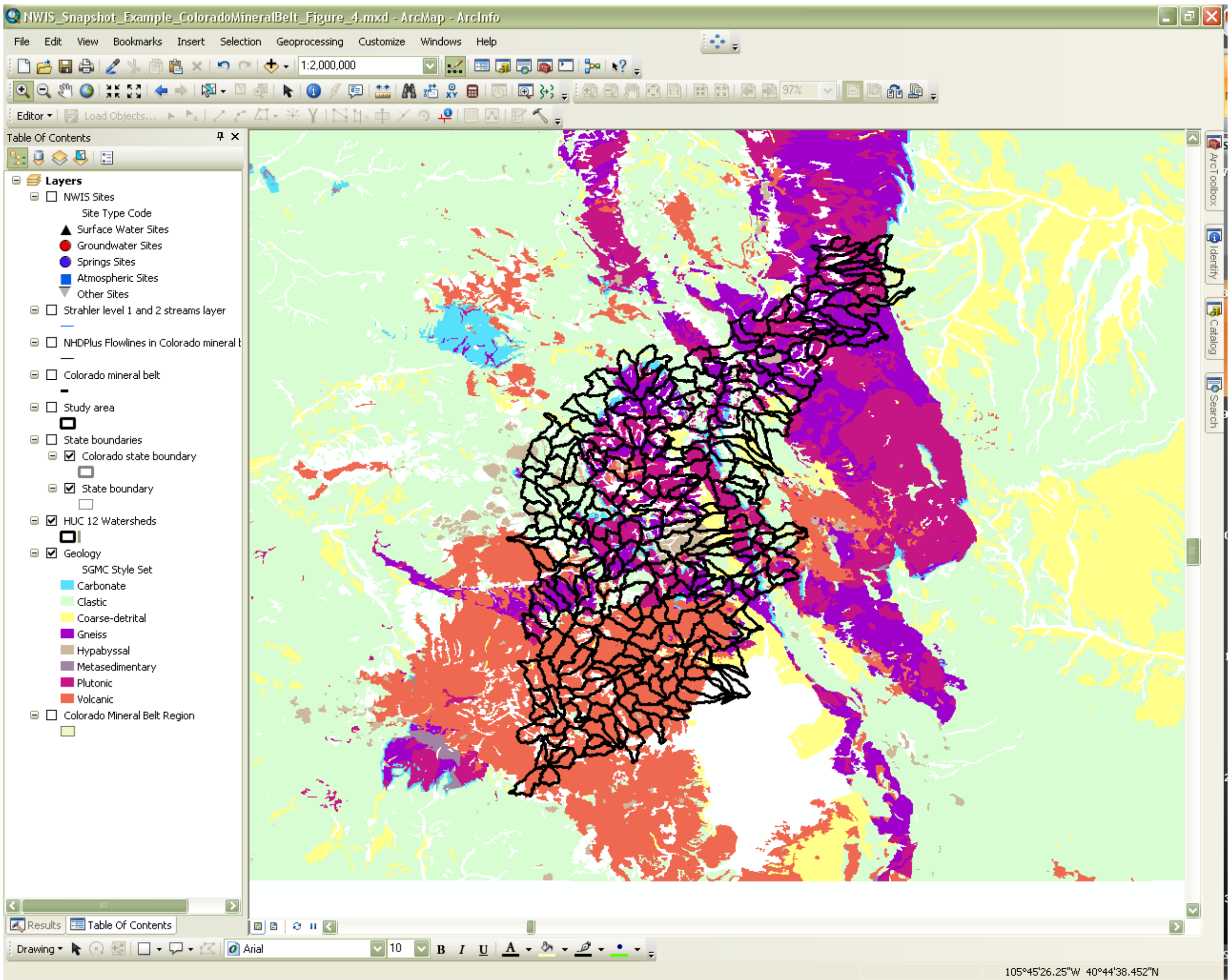
Figure 6. Strahler level one and two selection layer



B. Our second criteria is that the sites must be on Strahler level one and two streams located in catchments with relatively uniform, homogenous lithology. So we must compare our lithology data to our HUC 12 watersheds (catchments).

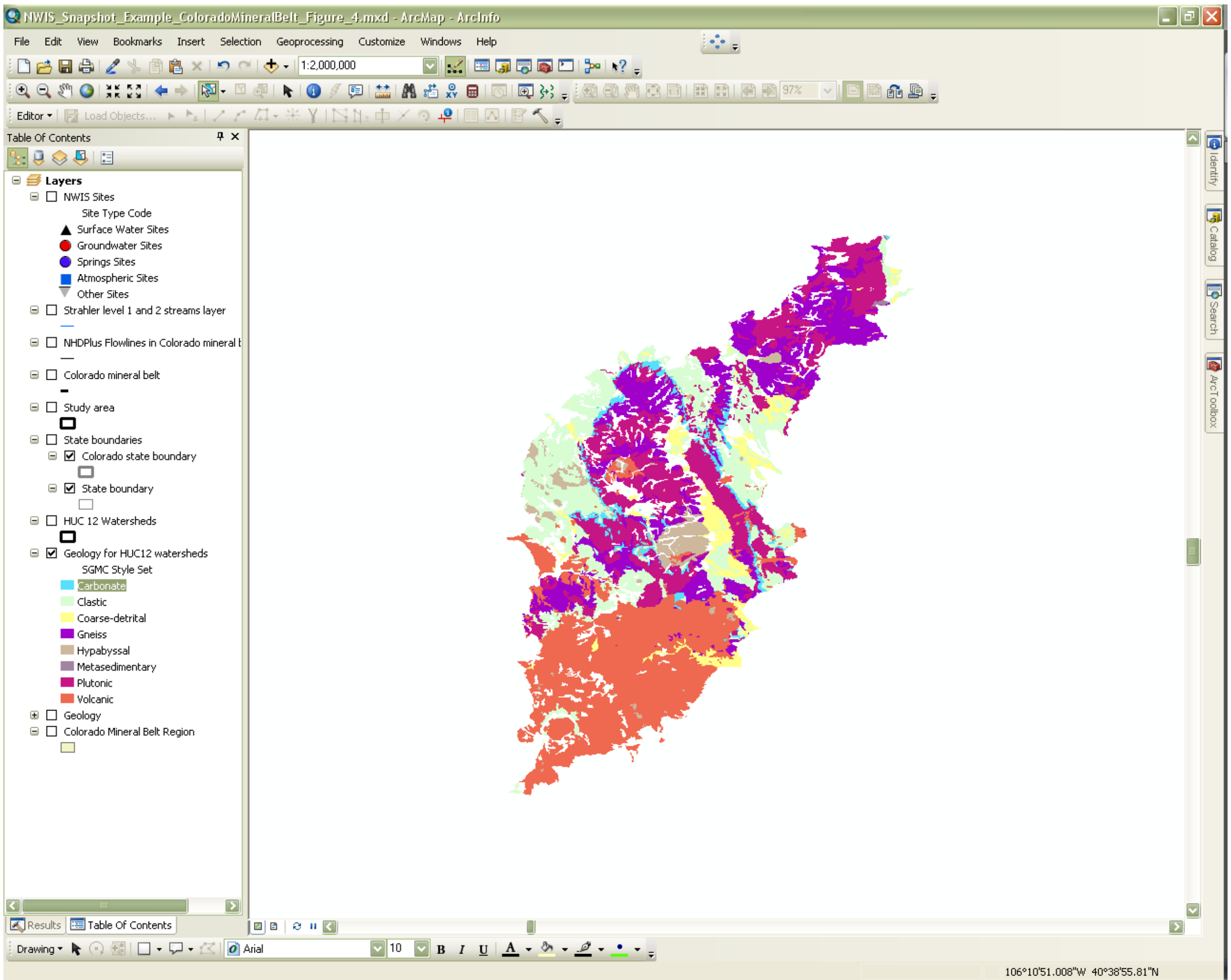
Step 1: Add geologic lithology group data and HUC 12 watersheds to project (Figure 7).

Figure 7. Geologic lithology group data and HUC 12 watersheds.



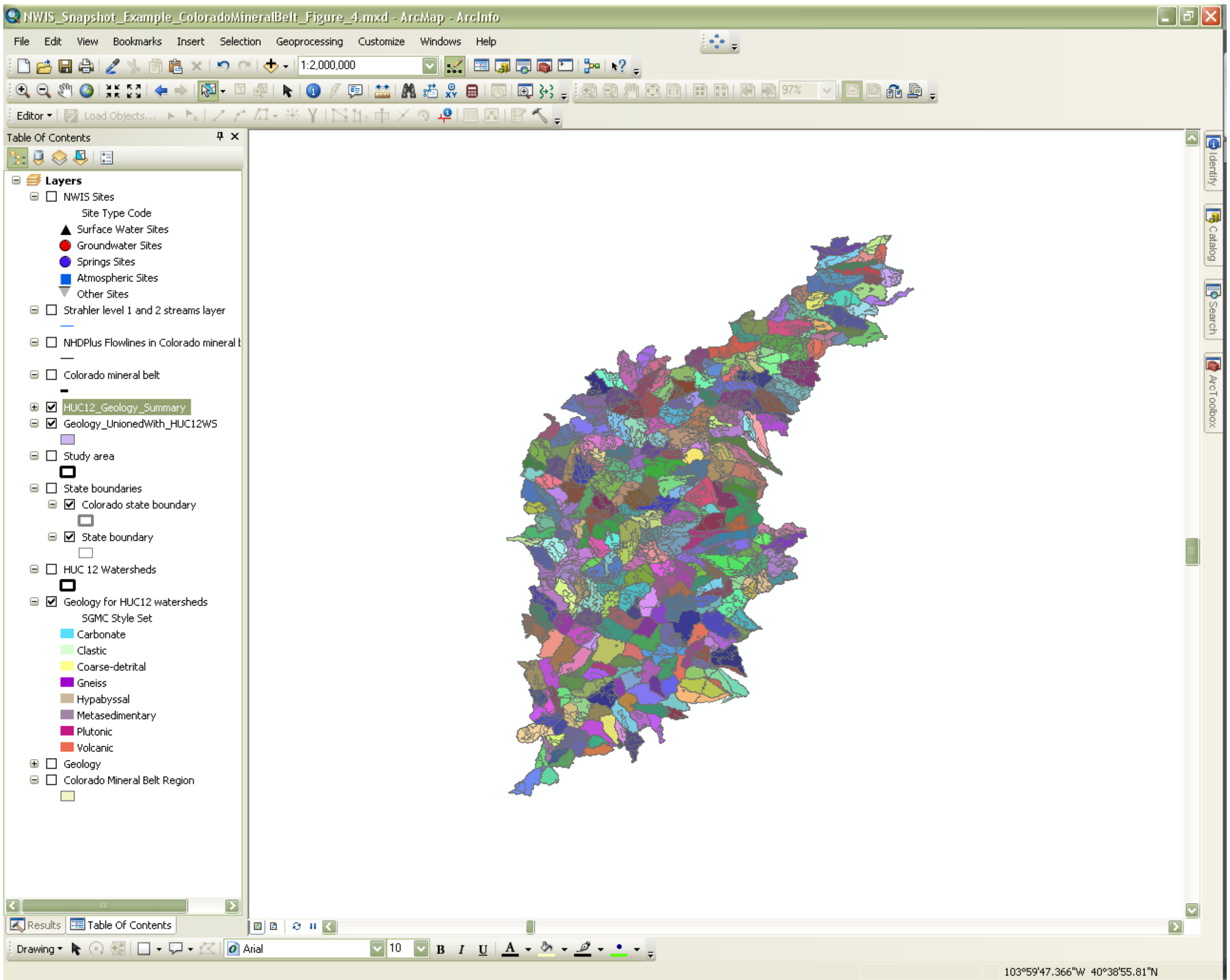
Step 2: Clip lithology by HUC 12 watersheds (Figure 8).

Figure 8. Geology clipped to HUC 12 watershed boundaries for Colorado mineral belt region.



Step 3: Union clipped geology with HUC 12 watershed boundaries (Figure 9).

Figure 9. Geology unioned with HUC 12 boundaries.



Step 4: Dissolve unioned geology by lithology group and HUC 12 value (Figure 10).

Figure 10. Unioned geology dissolved by lithology group and huc 12 code.

Table

HUC12_Geology_Summary

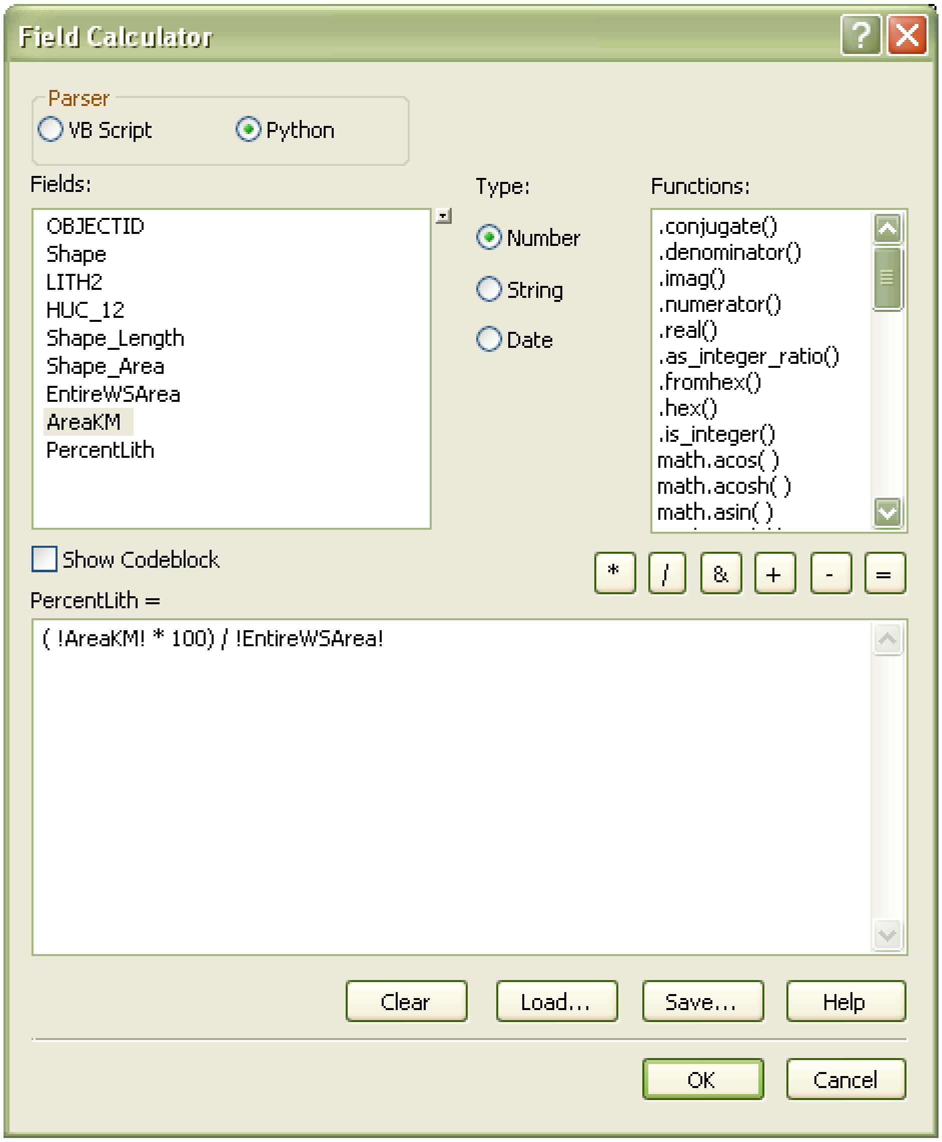
OBJECTID *	Shape *	LITH2	HUC_12	Shape_Length	Shape_Area
296	Polygon	Carbonate	140200010106	0.375939	0.000985
297	Polygon	Carbonate	140200010107	0.245615	0.000919
298	Polygon	Carbonate	140200010108	0.151037	0.000304
299	Polygon	Carbonate	140200010109	0.360768	0.001004
300	Polygon	Carbonate	140200010110	0.526048	0.001818
301	Polygon	Carbonate	140200010111	0.666389	0.002813
302	Polygon	Carbonate	140200010112	0.057696	0.000105
303	Polygon	Carbonate	140200010113	0.792912	0.00226
304	Polygon	Carbonate	140200010207	0.423748	0.001314
305	Polygon	Carbonate	140200010209	0.063235	0.000049
306	Polygon	Carbonate	140200010210	0.086162	0.000088
307	Polygon	Carbonate	140200030101	0.174886	0.000361
308	Polygon	Carbonate	140200030102	0.137907	0.000469
309	Polygon	Carbonate	140200030103	0.290406	0.001896
310	Polygon	Carbonate	140200030105	0.052582	0.000133
311	Polygon	Carbonate	140200030301	0.657786	0.001773
312	Polygon	Carbonate	140200030302	0.375672	0.00098
313	Polygon	Carbonate	140200030303	0.380904	0.001069
314	Polygon	Carbonate	140200030304	0.046342	0.000123
315	Polygon	Carbonate	140200030404	0.032772	0.000063
316	Polygon	Clastic	101900010101	0.281268	0.000826
317	Polygon	Clastic	101900010102	0.372598	0.001315
318	Polygon	Clastic	101900010103	0.605343	0.003611
319	Polygon	Clastic	101900010104	0.818783	0.004147
320	Polygon	Clastic	101900010105	0.881665	0.008538
321	Polygon	Clastic	101900010201	0.617376	0.004028
322	Polygon	Clastic	101900010202	0.399673	0.003875
323	Polygon	Clastic	101900010203	0.407496	0.003261
324	Polygon	Clastic	101900010204	0.659047	0.005985
325	Polygon	Clastic	101900010205	1.356872	0.00948
326	Polygon	Clastic	101900010208	0.496726	0.002857
327	Polygon	Clastic	101900010209	1.243818	0.004021
328	Polygon	Clastic	101900010401	0.736725	0.007238
329	Polygon	Clastic	101900010402	1.134524	0.004975
330	Polygon	Clastic	101900010403	0.554327	0.001842
331	Polygon	Clastic	101900010404	0.659413	0.002401
332	Polygon	Clastic	101900050103	0.265229	0.001196
333	Polygon	Clastic	101900050303	0.317179	0.002397
334	Polygon	Clastic	101900050405	0.225007	0.000802
335	Polygon	Clastic	101900050406	0.598363	0.003889
336	Polygon	Clastic	101900050503	0.047124	0.000029
337	Polygon	Clastic	101900050602	0.355249	0.002067
338	Polygon	Clastic	110200010103	0.033586	0.000016
339	Polygon	Clastic	110200010201	0.22078	0.000576
340	Polygon	Clastic	110200010202	1.066876	0.005821
341	Polygon	Clastic	110200010205	0.005674	0
342	Polygon	Clastic	110200010206	0.72691	0.00279
343	Polygon	Clastic	110200010207	0.32466	0.001044
344	Polygon	Clastic	110200010208	0.484747	0.001373
345	Polygon	Clastic	110200010209	0.013628	0.000007
346	Polygon	Clastic	110200010402	0.033959	0.000029
347	Polygon	Clastic	110200010404	0.127268	0.000268
348	Polygon	Clastic	110200010406	0.050449	0.000112
349	Polygon	Clastic	110200010501	0.001474	0
350	Polygon	Clastic	110200010502	0.053111	0.000095

1 (0 out of 1209 Selected)

HUC12_Geology_Summary

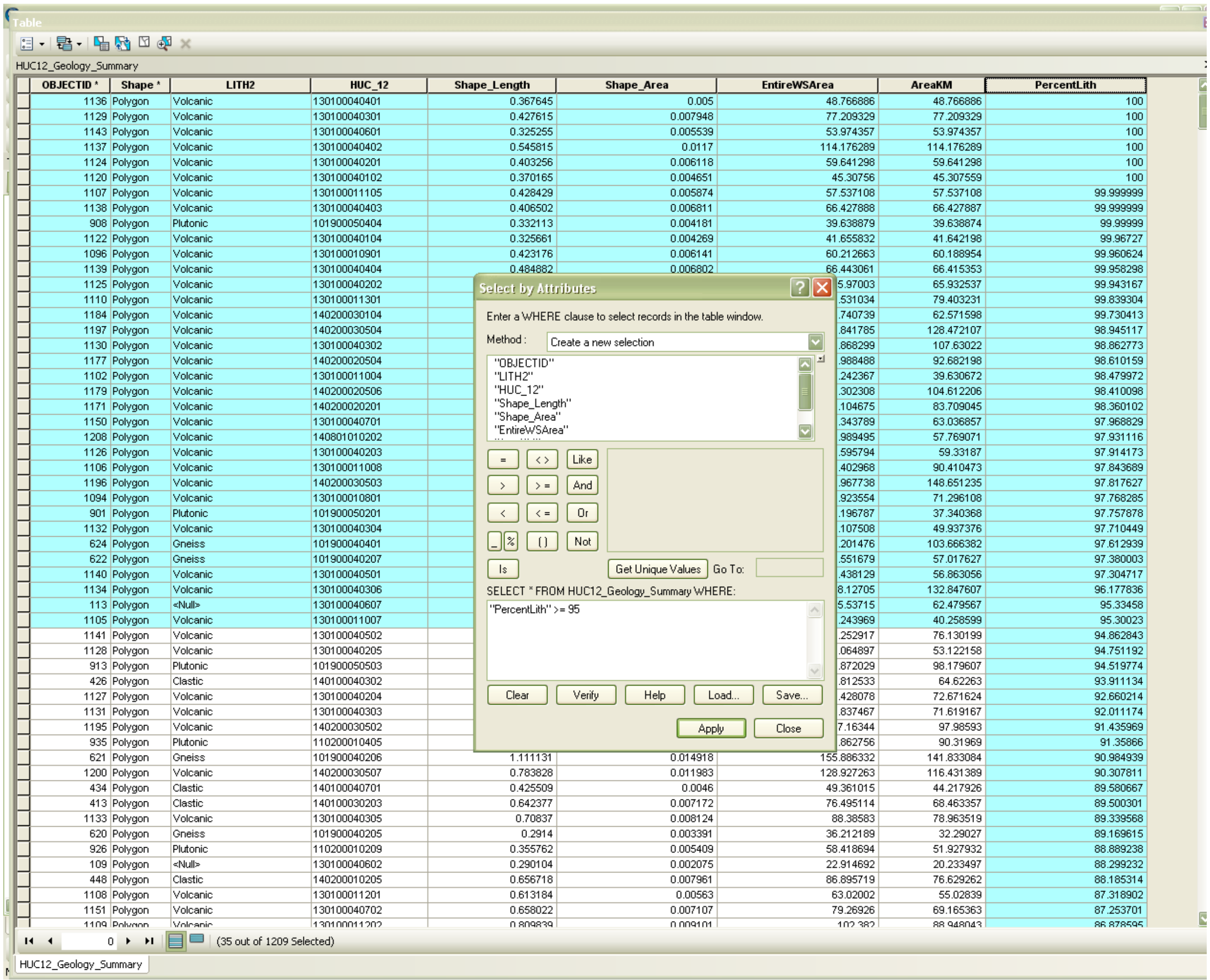
Step 5: Determine area of unioned lithology sections by HUC 12 region, and area of entire HUC 12 region, and then calculate the percentage of total watershed area per lithological group (Figure 11).

Figure 11. Determine the percentage of lithologic type per watershed catchment area.



Step 6: For this project, we will select all sections that are greater than 95% belonging to one lithology group, and consider those as relatively uniform and homogenous lithology (Figure 12).

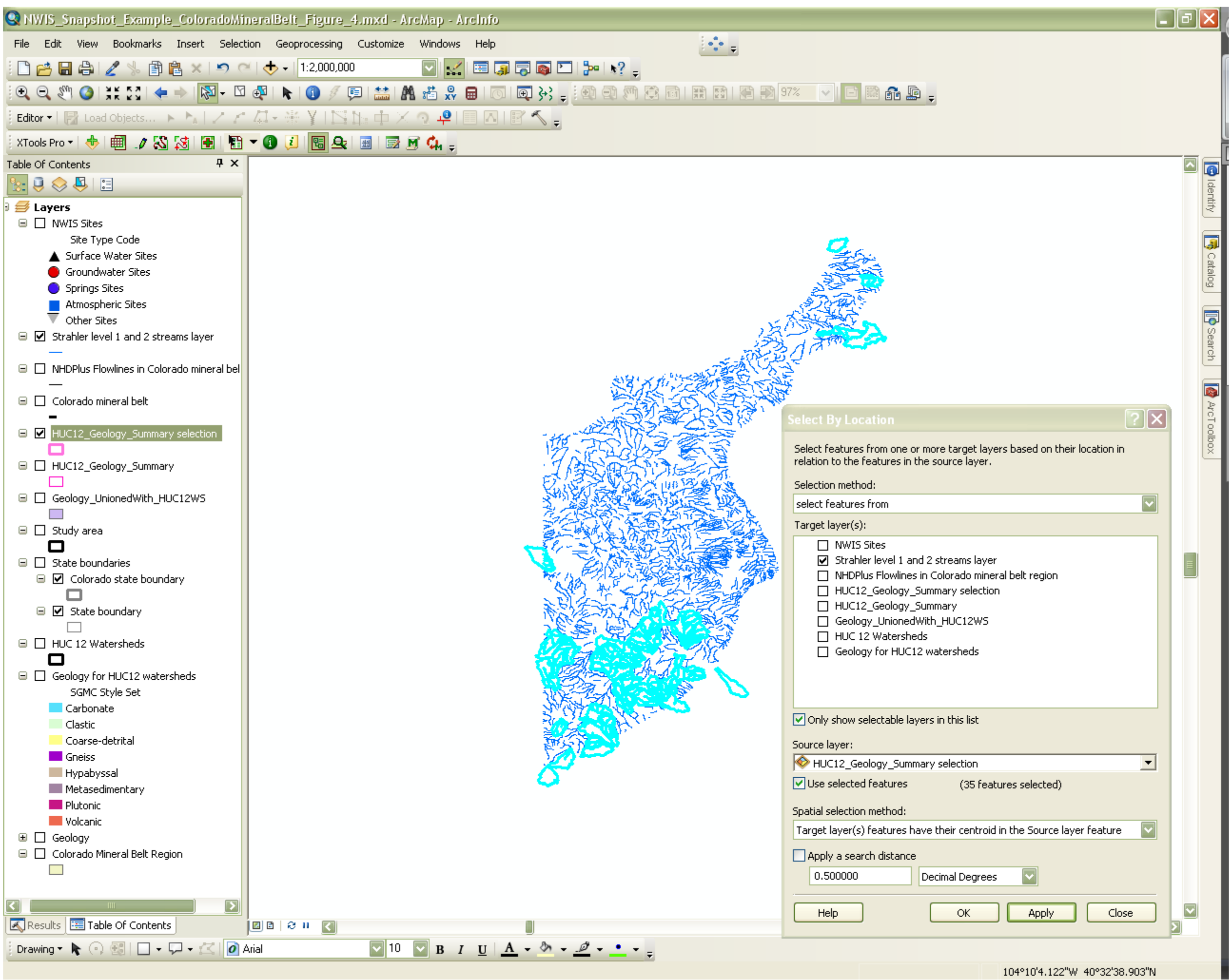
Figure 12. Select areas of greater than 95% one lithologic group per catchment.



C. Once we have identified the Strahler level one and two streams within the Colorado mineral belt, and we have determined which catchments are located in areas of relatively uniform, homogenous lithology, we have the necessary components to determine which streams fit all of our criteria. We will now locate all Strahler level one and two streams located in our homogenous catchments.

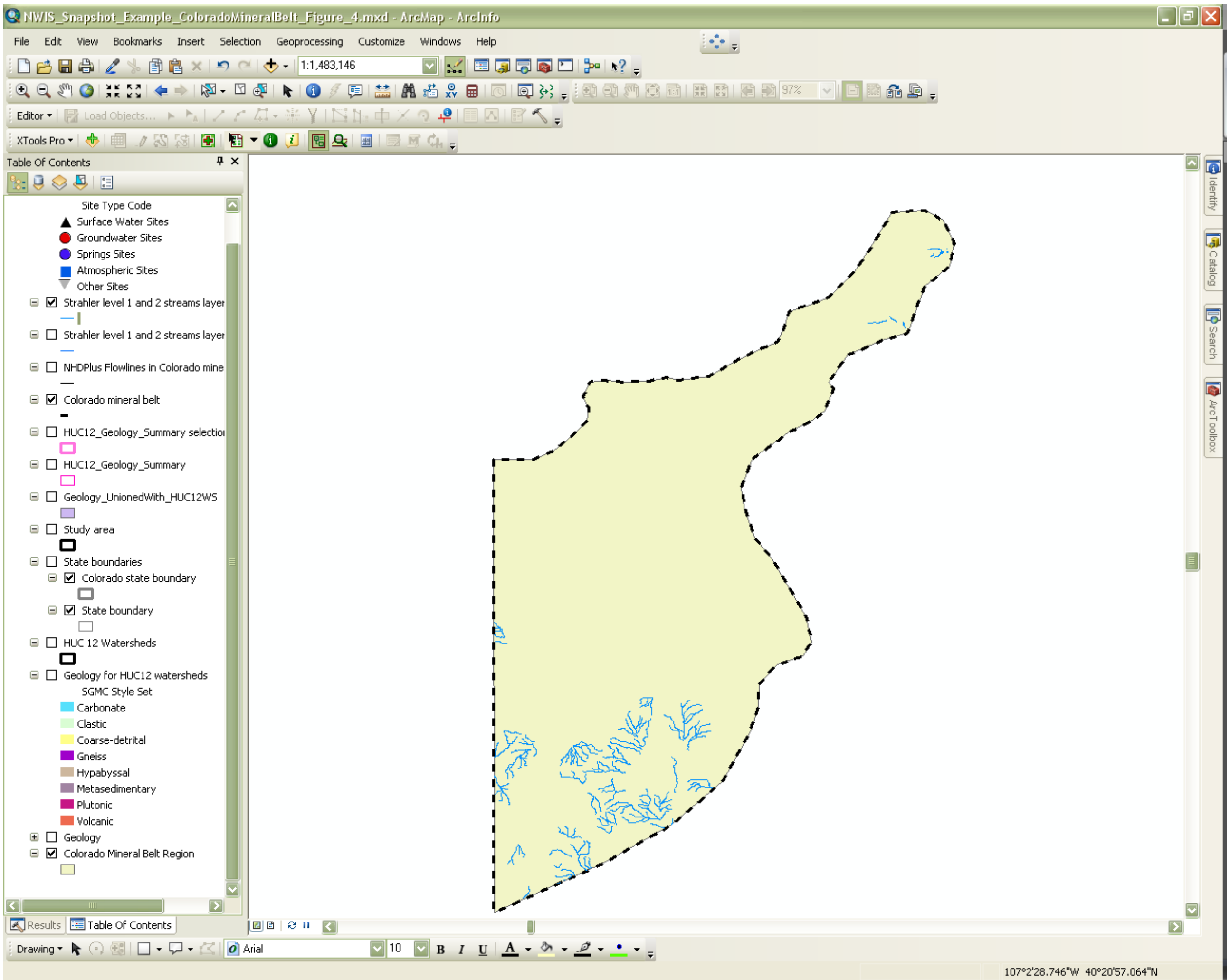
Step 10: Select all Strahler level one and two streams within the selected catchments (Figure 13).

Figure 13. Strahler level one and two streams within homogenous catchments.



Terrific! Now you have all of the Strahler level one and two streams that are located in relatively homogenous catchments, so you can now determine which NWIS Water Quality monitoring stations will contain information pertinent to your study (Figure 14).

Figure 14. All Strahler level one and two streams that are within homogenous catchment areas.

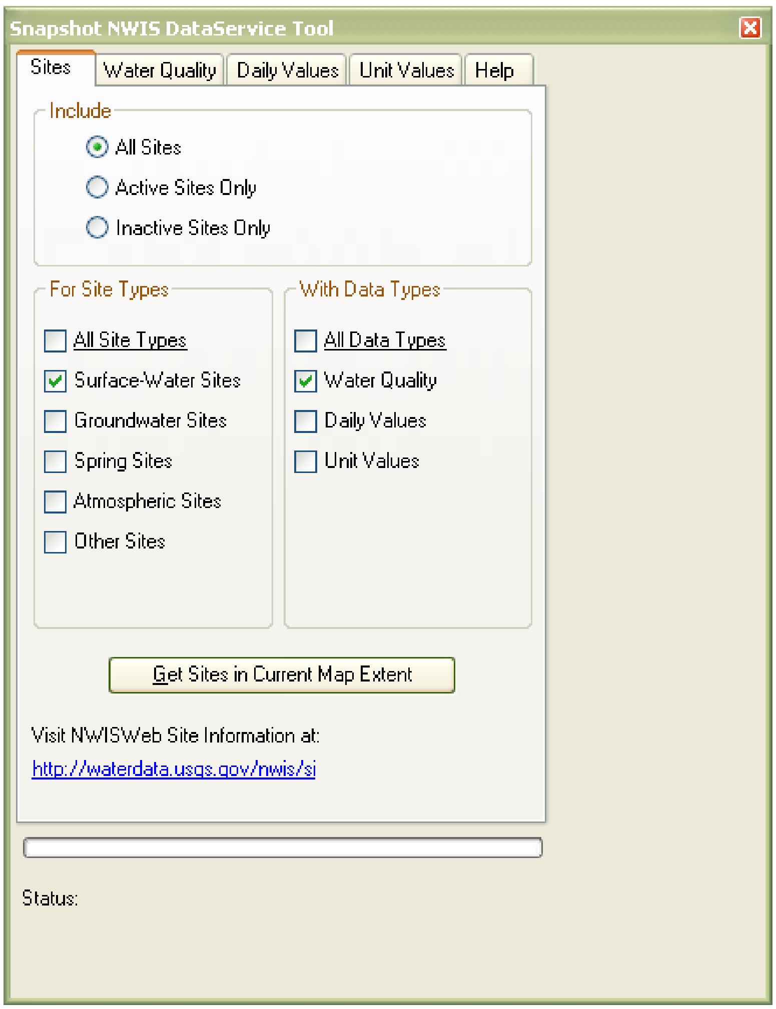


Acquire water quality data for streams of interest

After we have identified the streams we are interested in, we need to obtain water quality information for those streams. For this case study, we are interested in the levels of silver, lead, copper, zinc, found in our streams, and the pH of the water for those streams as well. According to Wanty and co-authors, most of the acidic drainage (pH < 5) sampled in their study resulted from impacts of historical mines, although many natural acid drainages exist.

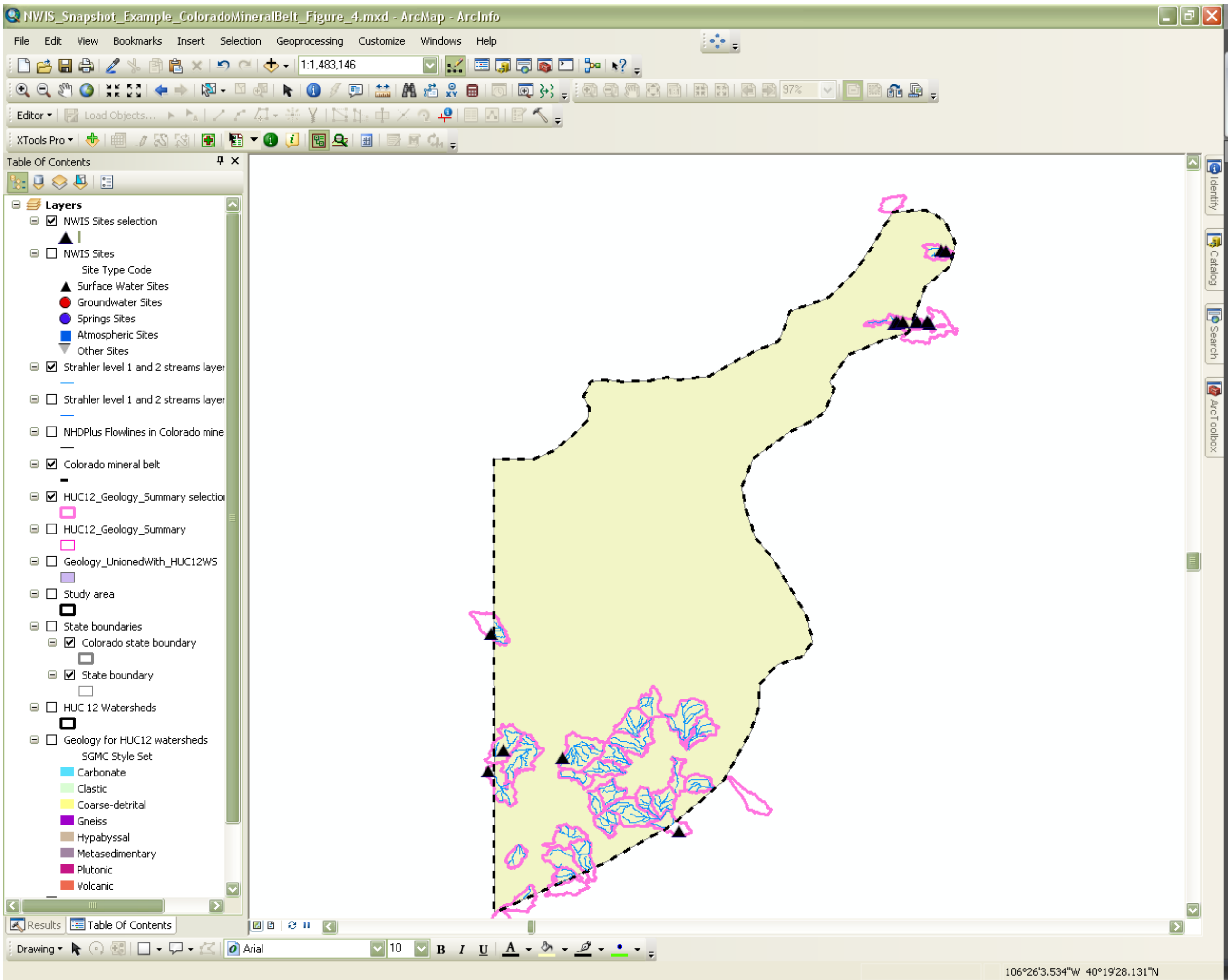
Step 1: Get the surface water sites with water quality data for the extent surrounding the Colorado mineral belt using the Sites tab of the Snapshot NWIS DataService Tool (Figure 15).

Figure 15. Use the NWIS Snapshot tool to load the sites of interest into ArcMap.



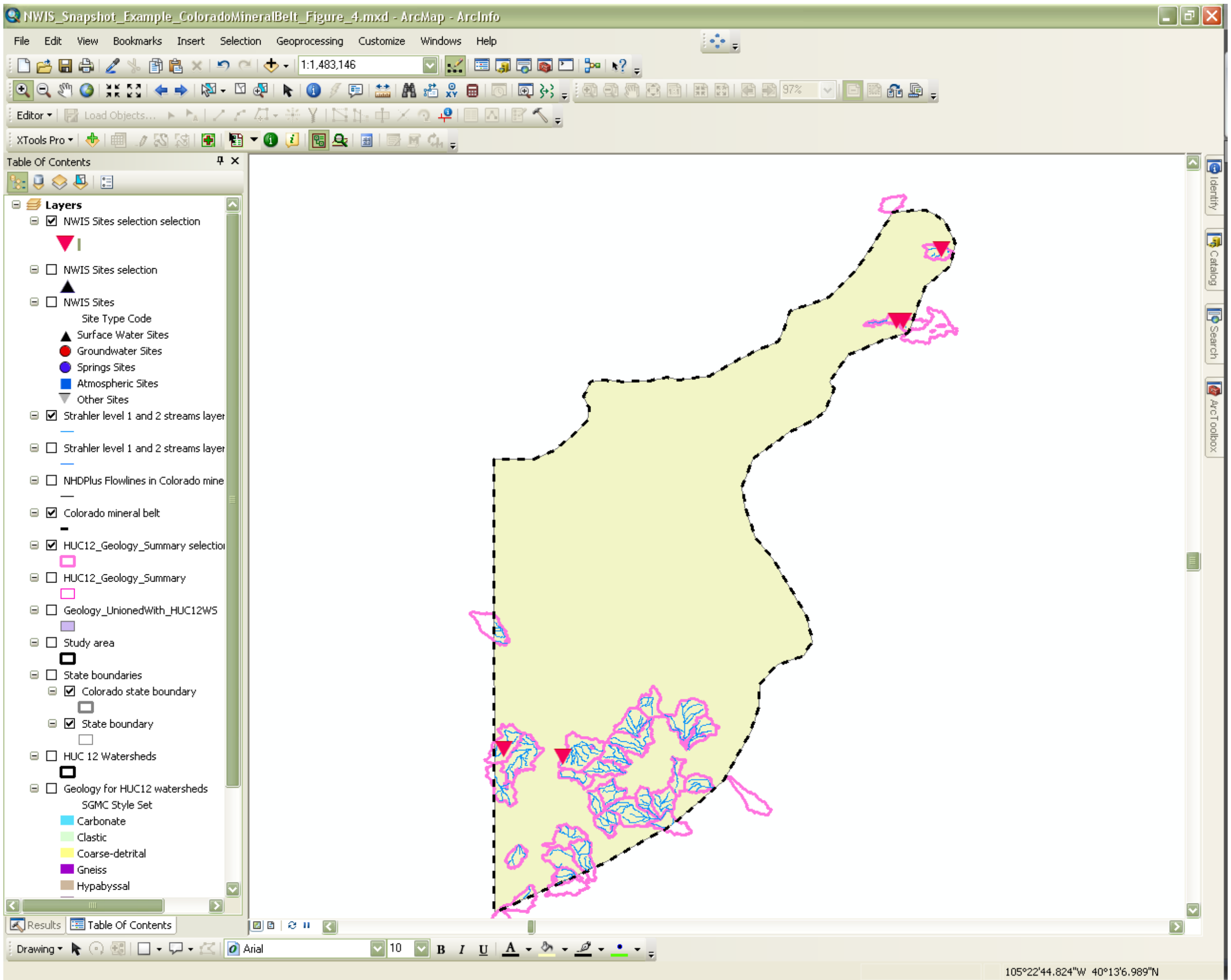
Step 2: Create a selection layer for all NWIS sites that are within our selected catchments (Figure 16).

Figure 16. All NWIS Sites within catchments of interest.



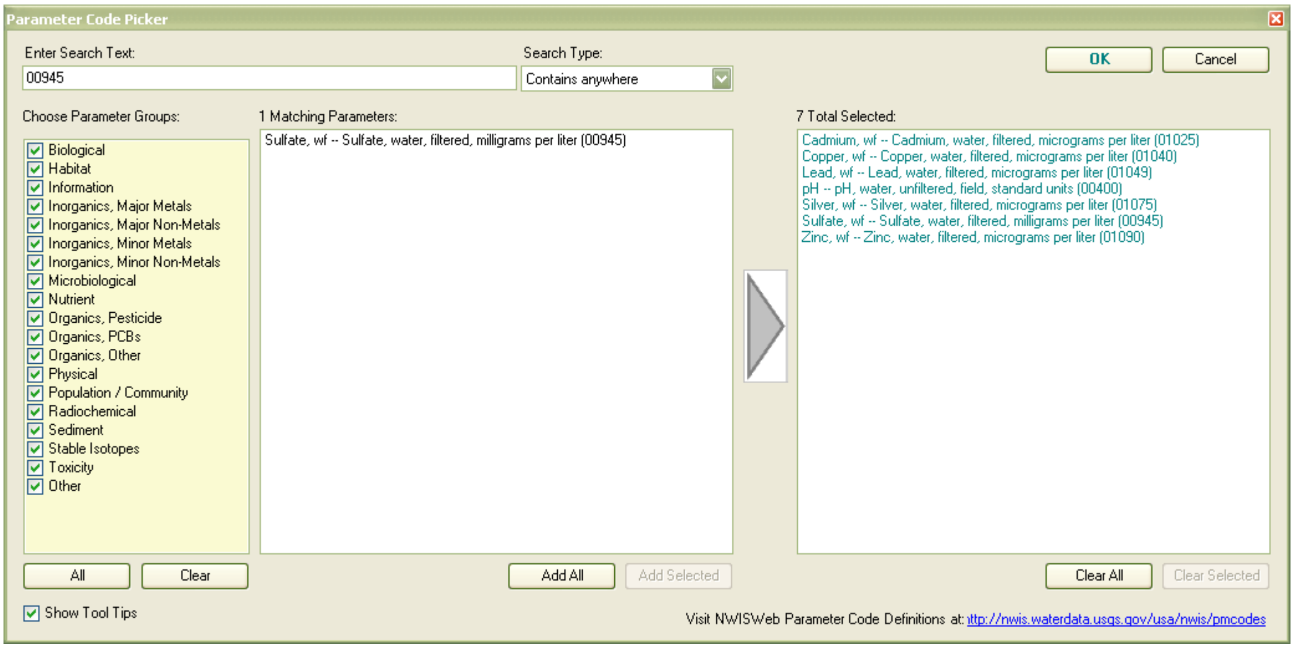
Step 3: Select all NWIS sites located on our level one and two streams (Figure 17).

Figure 17. All NWIS sites on level one and two streams.



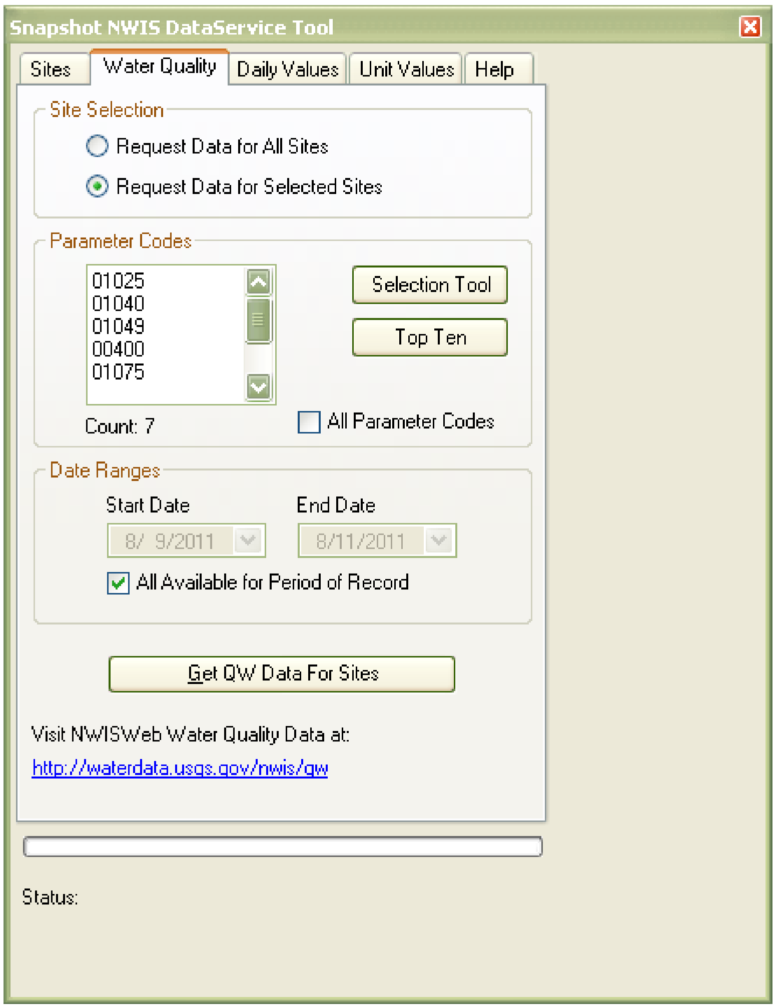
Step 4: Use NWIS Snapshot tool to download water quality data for our parameters of interest for the selected sites. Begin by using the parameter code picker tool to select your parameters (Figure 18).

Figure 18. Parameter code picker with Cadmium 01025, Copper 01040, Lead 01049, pH 00400, Silver 01075, Sulfate 00945, and Zince 01090 selected.



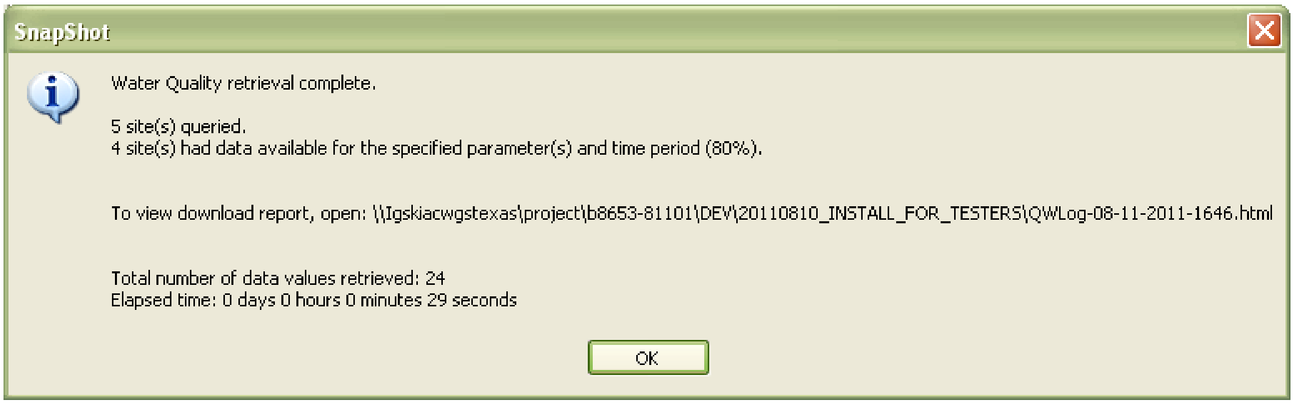
Step 5: Download all water quality data available for these paramaters for our sites for the available period of record (0). Note, be sure to change the name of your selection layer to NWIS Sites!

Figure 19. Snapshot tool with settings to download all available data for period of record for our parameters of interest.



Fantastic! Now we have our water quality data for our sites of interest (Figure 20), and we can move on to changing the look of our data to help us examine it better using a pivot table.

Figure 20. The NWIS Snapshot Tool has downloaded 24 water quality records for our 5 sites, although only 4 of them had data.



How to make a pivot table

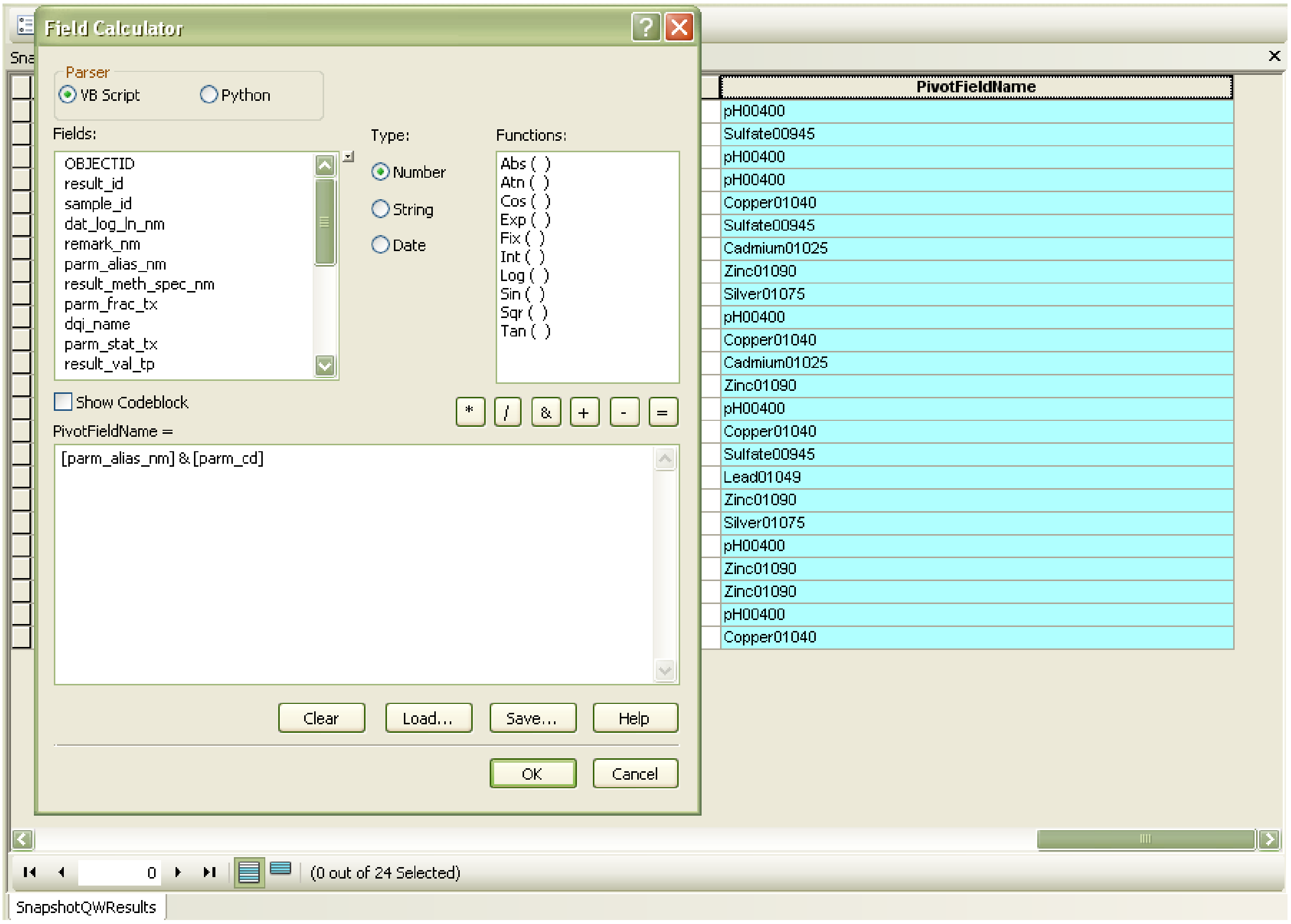
Sometimes you may want to change the arrangement of rows and columns and results in a data table. The NWIS Snapshot tool provides your data in a long table with all of the parameters for each of your sites stacked on top of one another, and if you have a large number of sites and parameters, this might make visually examining your data table a little cumbersome (Figure 21). If you take the parameters and swing them over to become new columns for your sites, with the results next to each site, it may be easier to view the results.

Figure 21. Vertical presentation of water quality data.

io	Parameter Name	M	Sample Fractio	Result Stat	S	Result Valu	Re	Re	R	Re	Result	R	USGS P	Result Value	Result Unit
	pH		Total	Historical		Actual					field		00400	9.1	std units
	Sulfate		Dissolved	Historical		Actual							00945	4.7	mg/l
	pH		Total	Historical		Actual					field		00400	8.1	std units
	pH		Total	Historical		Actual					field		00400	3	std units
	Copper		Dissolved	Historical		Actual					field		01040	10000	ug/l
	Sulfate		Dissolved	Historical		Actual					field		00945	1700	mg/l
	Cadmium		Dissolved	Historical		Actual					field		01025	520	ug/l
d	Zinc		Dissolved	Historical		Actual					field		01090	99000	ug/l
d	Silver		Dissolved	Historical		Actual					field		01075	0	ug/l
d	pH		Total	Historical		Actual					field		00400	2.8	std units
d	Copper		Dissolved	Historical		Actual					field		01040	8400	ug/l
ec	Cadmium		Dissolved	Historical		Actual					field		01025	350	ug/l
d	Zinc		Dissolved	Historical		Actual					field		01090	63000	ug/l
	pH		Total	Historical		Actual					field		00400	7.9	std units
	Copper		Dissolved	Historical		Actual					field		01040	20	ug/l
	Sulfate		Dissolved	Historical		Actual					field		00945	83	mg/l
d	Lead		Dissolved	Historical		Actual					field		01049	0	ug/l
d	Zinc		Dissolved	Historical		Actual					field		01090	800	ug/l
d	Silver		Dissolved	Historical		Actual					field		01075	2	ug/l
d	pH		Total	Historical		Actual					field		00400	6.8	std units
ec	Zinc		Dissolved	Historical		Actual					field		01090	660	ug/l
d	Zinc		Dissolved	Historical		Actual					field		01090	190	ug/l
d	pH		Total	Historical		Actual					field		00400	6.9	std units
d	Copper		Dissolved	Historical		Actual					field		01040	20	ug/l

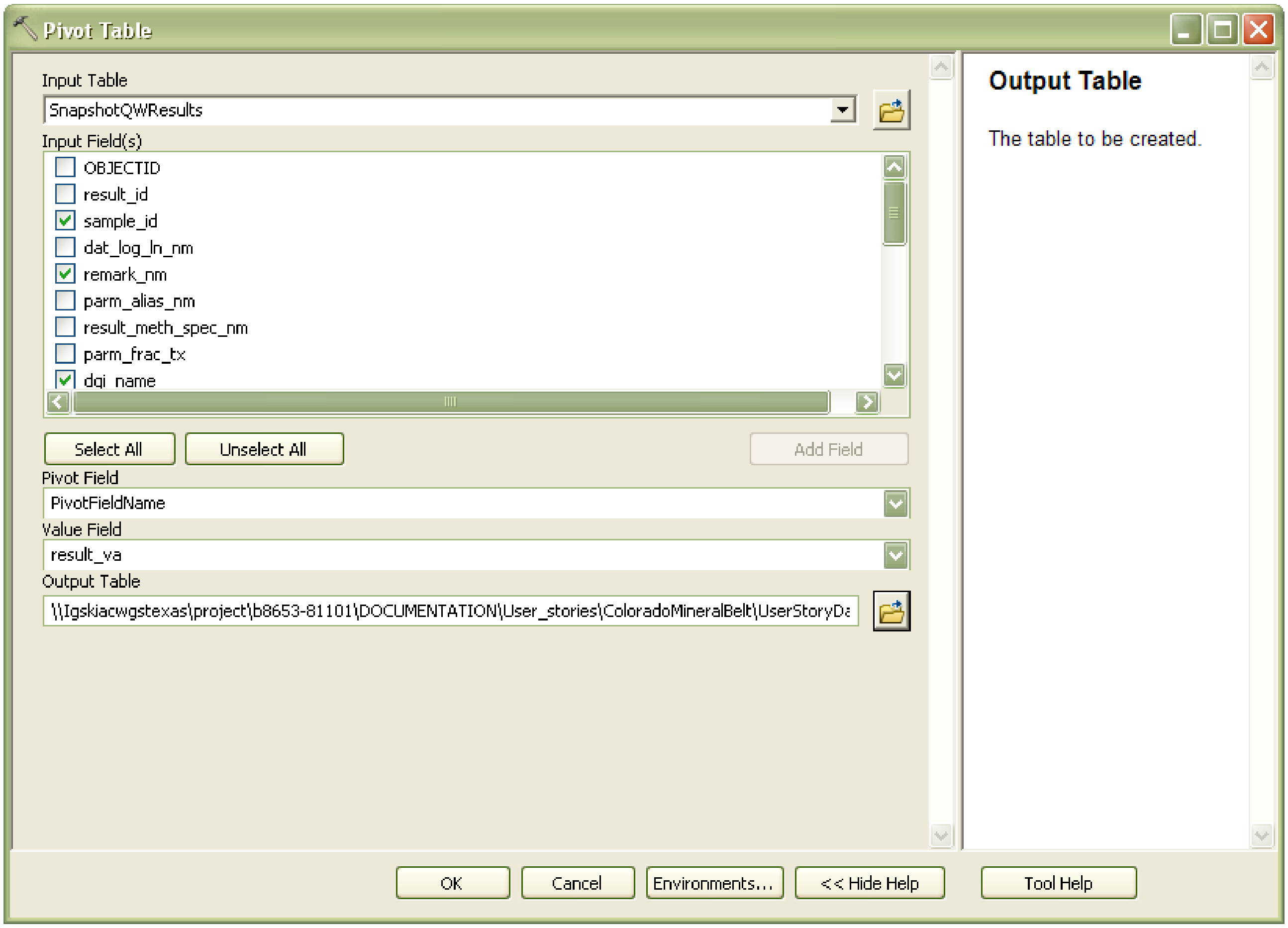
Step 1: Add a new field named "PivotFieldName" to your results table and calculate it to be equal to the parameter name and the parameter code concatenated together (Figure 22).

Figure 22. Calculating names for the PivotFieldName field.



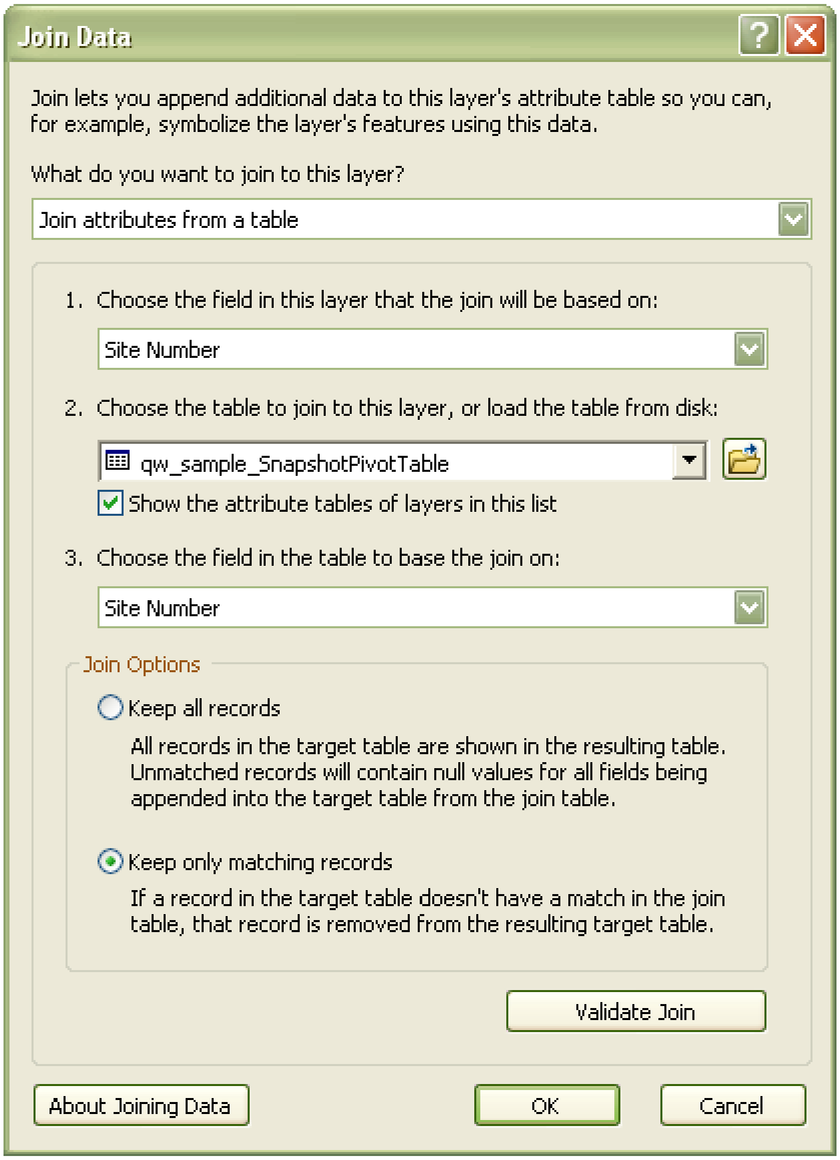
Step 2: Use the ArcMap Pivot Table tool to adjust the arrangement of field, records, and values (0).

Figure 23. ArcMap Pivot Table tool with setting for making a pivot table.



Step 3: Now if you join the NWIS Snapshot Sample table to your pivot table, and then join your selected sites to the joined sample-result table, you can view the water quality for your sites! (Figure 24).

Figure 24. Joining our sites to the samples which have been joined to our pivot table.



At last! You can now see that on December 15, 1971, Virginia Canyon Creek had significant levels of Cadmium, Copper and Sulfate, and a high level of acidity, likely due to mining activities (Figure 25).

Figure 25. Final water quality results for our sites of interest.

Table

Sites_With_Results

OBJECTID *	Station Name	Sample St	Result Stat	Result	Resu	Cadmium01025	Copper01040	Lead01049	pH00400	Silver01075	Sulfate00945	Zinc01090
1	ROCK CREEK (ROCK CREEK PARK)	8/20/1981	Historical	Actual	field	0	0	0	9.1	0	0	0
2	VAN TASSEL GULCH (IN UPPER COCHETOPA)	8/24/1978	Historical	Actual		0	0	0	0	0	4.7	0
3	VIRGINIA CANYON C AT MO AT IDAHO SPRGS, CO	12/15/1971	Historical	Actual	field	520	10000	0	3	0	1700	0
4	CLEAR C AB STP OUTFALL @ IDAHO SPRINGS, CO	12/22/1971	Historical	Actual	field	0	20	0	7.9	0	83	0